

## Module 9 - Strain Gauges

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

### Topic 2 - The Wheatstone Bridge

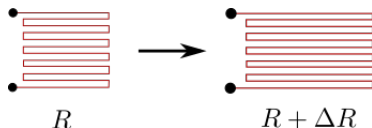
## Topic 2 - The Wheatstone Bridge

- Resistive Gauges
- The Bridge Circuit
- Balancing the Bridge
- Gauge Sensitivity

## Resistive Gauges

The resistive strain gauge, aka *metallic gauge*, is bonded to the surface so that it deforms with the specimen. The change in length of the bonded gauge causes a change in resistance which is used as a measure of strain.

$$R = \rho_e L / A_c = fn(L, \dots)$$



This is an exaggerated picture so the change is very small...

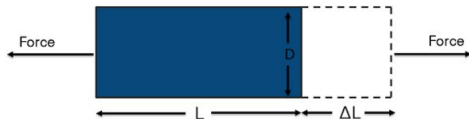
Images: T.Hill

## Resistive Gauges

The **Gauge Factor** is typically used instead of the physical parameters.

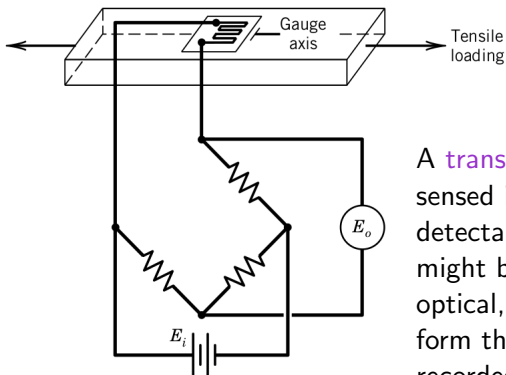
$$GF \equiv \frac{\delta R/R}{\delta L/L} = \frac{\delta R/R}{\epsilon_a}$$

This number relates the relative change in resistance to the measured strain.



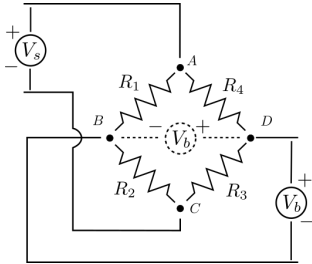
Images: NI

## The Bridge Circuit



A **transducer** converts the sensed information into a detectable signal. The signal might be mechanical, electrical, optical, or may take any other form that can be meaningfully recorded.

# The Bridge Circuit



Images: T.Hill

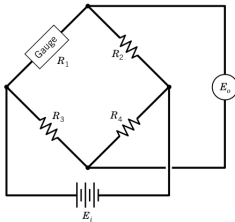
How does the bridge circuit work as a transducer?

Use KVL and the voltage divider rule find the relationship between the two voltages.

$$V_b = \left( \frac{R_3}{R_3 + R_4} - \frac{R_2}{R_1 + R_2} \right) \times V_s$$

## Balancing the Bridge

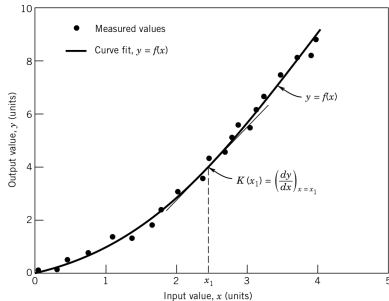
If all four resistors are equal the bridge voltage will equal zero and the bridge is said to be **balanced**. One or more resistors in the circuit is replaced by a strain gauge and bridge voltage is used as a measure of change in resistance and therefore strain.



This gives a linear **calibration curve** with a convenient **zero offset**.

Text. Images: Theory and Design for Mechanical Measurements

# Gauge Sensitivity



Assume  $R = 120\Omega$  for all resistors and the bridge is balanced in a condition of zero strain. What is the **static sensitivity** of the gauge and bridge circuit described?

$K =$

Text. Images: Theory and Design for Mechanical Measurements



# Gauge Sensitivity

# Gauge Sensitivity